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Practitioner's Docket No. 55,595 (45107)

CHAPTER II

TRANSMITTAL LETTER TO THE UNITED STATES ELECTED OFFICE (EO/US)

(ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

PCT/DE99/02406	August 2, 1999	August 7, 1998
INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED

METHOD AND ARRANGEMENT FOR MOTION ESTIMATION IN A DIGITIZED PICTURE HAVING PIXELS

TITLE OF INVENTION

Jürgen PANDEL; Gero BÄSE; Norbert ÖRTEL

APPLICANT(S)

Box PCT
Assistant Commissioner for Patents
Washington D.C. 20231
ATTENTION: EO/US

NOTE. To avoid abandonment of the application, the applicant shall furnish to the USPTO, not later than 20 months from the priority date: (1) a copy of the international application, unless it has been previously communicated by the International Bureau or unless it was originally filed in the USPTO; and (2) the basic national fee (see 37 C.F.R. § 1.492(a)). The 30-month time limit may not be extended. 37 C.F.R. § 1.495.

CERTIFICATION UNDER 37 C.F.R. 1.10*
*(Express Mail label number is **mandatory**.)*
(Express Mail certification is optional.)

I hereby certify that this correspondence and the documents referred to as attached therein are being deposited with the United States Postal Service on this date **February 6, 2001**, in an envelope as "Express Mail Post Office to Addressee," Mailing Label Number **EL196831827US**, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Laura M. McGuire
(type or print name of person mailing paper)

Signature of person mailing paper

WARNING: *Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.*

***WARNING:** Each paper or fee filed by "Express Mail" **must** have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. 1.10(b).*
*"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.*

WARNING: *Where the items are those which can be submitted to complete the entry of the international application into the national phase are subsequent to 30 months from the priority date the application is still considered to be in the international state and if mailing procedures are utilized to obtain a date the express mail procedure of 37 C.F.R. §1.10 must be used (since international application papers are not covered by an ordinary certificate of mailing - See 37 C.F.R. §1.8.*

NOTE: *Documents and fees must be clearly identified as a submission to enter the national state under 35 USC 371 otherwise the submission will be considered as being made under 35 USC 111. 37 C.F.R. § 1.494(f).*

1. Applicant herewith submits to the United States Elected Office (EO/US) the following items under 35 U.S.C. 371:

   a. [X] This express request to immediately begin national examination procedures (35 U.S.C. 371(f)).

   b. [✗] The U.S. National Fee (35 U.S.C. 371(c)(1)) and other fees (37 C.F.R. § 1.492) as indicated below:

2.Fees

CLAIMS FEE	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
[ ]	TOTAL CLAIMS	10 -20 =		x $ 18.00 =	$0
	INDEPENDENT CLAIMS	2 - 3 =		x $ 78.00 =	0
	MULTIPLE DEPENDENT CLAIM(S) (if applicable) + $260.00				260.00
BASIC FEE**	[ ] U.S. PTO WAS INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where an International preliminary examination fee as set forth in § 1.482 has been paid on the international application to the U.S. PTO: [ ] and the international preliminary examination report states that the criteria of novelty, inventive step (non-obviousness) and industrial activity, as defined in PCT Article 33(2) to (4) have been satisfied for all the claims presented in the application entering the national stage (37 CFR 1.492(a)(4)) . ..... $96.00 [ ] and the above requirements are not met (37 CFR 1.492(a)(1)) ..... $670.00 [X] U.S. PTO WAS NOT INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where no international preliminary examination fee as set forth in § 1.482 has been paid to the U.S. PTO, and payment of an international search fee as set forth in § 1.445(a)(2) to the U.S. PTO: [ ] has been paid (37 CFR 1.492(a)(2)) ..... $760.00 [ ] has not been paid (37 CFR 1.492(a)(3)) ..... $970.00 [X] where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 CFR 1.492(a)(5)) $840.00				$ 840.00
				Total of above Calculations	=$ 1110.00
SMALL ENTITY	Reduction by ½ for filing by small entity, if applicable. Affidavit must be filed. (note 37 CFR 1.9, 1.27, 1.28)				-
				Subtotal	$ 1110.00
				Total National Fee	$
	Fee for recording the enclosed assignment document $40.00 (37 CFR 1.21(h)). (See Item 13 below). See attached "ASSIGNMENT COVER SHEET".				
TOTAL				Total Fees enclosed	$ 1110.00

i. [X] A check in the amount of $ 1110.00 cover the above fees is enclosed.
ii. [ ] Please charge Account No. _____ in the amount of $ _____.
A duplicate copy of this sheet is enclosed.

***WARNING:* *"To avoid abandonment of the application the applicant shall furnish to the United States Patent and Trademark Office not later than the expiration of 30 months from the priority date: * * * (2) the basic national fee (see § 1.492(a)). The 30-month time limit may not be extended." 37 C.F.R. § 1.495(b).*

WARNING: *If the translation of the international application and/or the oath or declaration have not been submitted by the applicant within thirty (30) months from the priority date, such requirements may be met within a time period set by the Office. 37 C.F.R. § 1.495(b)(2). The payment of the surcharge set forth in § 1.492(e) is required as a condition for accepting the oath or declaration later than thirty (30) months after the priority date. The payment of the processing fee set forth in § 1.492(f) is required for acceptance of an English translation later than thirty (30) months after the priority date. Failure to comply with these requirements will result in abandonment of the application. The provisions of § 1.136 apply to the period which is set. Notice of Jan. 3, 1993, 1147 O.G. 29 to 40.*

3. [**X**] A copy of the International application as filed (35 U.S.C. 371(c)(2)):

NOTE: *Section 1.495 (b) was amended to require that the basic national fee and a copy of the international application must be filed with the Office by 30 months from the priority date to avoid abandonment "The International Bureau normally provides the copy of the international application to the Office in accordance with PCT Article 20. At the same time, the International Bureau notifies applicant of the communication to the Office. In accordance with PCT Rule 47.1, that notice shall be accepted by all designated offices as conclusive evidence that the communication has duly taken place. Thus, if the applicant desires to enter the national stage, the applicant normally need only check to be sure the notice from the International Bureau has been received and then pay the basic national fee by 30 months from the priority date." Notice of Jan. 7, 1993, 1147 O.G. 29 to 40, at 35-36. See item 14c below.*

a. [X] is transmitted herewith.
b. [ ] is not required, as the application was filed with the United States Receiving Office.
c. [ ] has been transmitted
i. [ ] by the International Bureau.
Date of mailing of the application (from form PCT/IB/308): _____.
ii. [ ] by applicant on _____.
Date

4. [**X**] A translation of the International application into the English language (35 U.S.C. 371(c)(2)):
a. [**X**] is transmitted herewith.
b. [ ] is not required as the application was filed in English.
c. [ ] was previously transmitted by applicant on _____.
Date
d. [ ] will follow.

5. [X] Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. 371(c)(3)):

NOTE: The Notice of January 7, 1993 points out that 37 C.F.R. § 1.495(a) was amended to clarify the existing and continuing practice that PCT Article 19 amendments must be submitted by 30 months from the priority date and this deadline may not be extended. The Notice further advises that: "The failure to do so will not result in loss of the subject matter of the PCT Article 19 amendments. Applicant may submit that subject matter in a preliminary amendment filed under section 1.121. In many cases, filing an amendment under section 1 121 is preferable since grammatical or idiomatic errors may be corrected." 1147 O.G. 29-40, at 36.

a. [ ] are transmitted herewith.
b. [ ] have been transmitted
   i. [ ] by the International Bureau.
   Date of mailing of the amendment (from form PCT/IB/308): _____.
   ii. [ ] by applicant on _____.
   Date
c. [X] have not been transmitted as
   i. [X] applicant chose not to make amendments under PCT Article 19.
   Date of mailing of Search Report (from form PCT/ISA/210): January 19, 2000.
   ii. [ ] the time limit for the submission of amendments has not yet expired. The amendments or a statement that amendments have not been made will be transmitted before the expiration of the time limit under PCT Rule 46.1.

6. [X] A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. 371(c)(3)):
a. [ ] is transmitted herewith.
b. [ ] is not required as the amendments were made in the English language.
c. [X] has not been transmitted for reasons indicated at point 5(c) above.

7. [X] A copy of the international examination report (PCT/IPEA/409)
[X] is transmitted herewith.
[ ] is not required as the application was filed with the United States Receiving Office.

8. [X] Annex(es) to the international preliminary examination report
a. [X] is/are transmitted herewith.
b. [ ] is/are not required as the application was filed with the United States Receiving Office.

9. [X] A translation of the annexes to the international preliminary examination report
a. [X] is transmitted herewith.
b. [ ] is not required as the annexes are in the English language.

10. [X] An oath or declaration of the inventor (35 U.S.C. 371(c)(4)) complying with 35 U.S.C. 115
a. [ ] was previously submitted by applicant on _____.
   Date
b. [ ] is submitted herewith, and such oath or declaration
   i. [ ] is attached to the application.

ii. [ ] identifies the application and any amendments under PCT Article 19 that were transmitted as stated in points 3(b) or 3(c) and 5(b); and states that they were reviewed by the inventor as required by 37 C.F.R. 1.70.

iii. [X] will follow.

Other document(s) or information included:

11. [X] An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a):
   a. [X] is transmitted herewith.
   b. [ ] has been transmitted by the International Bureau.
      Date of mailing (from form PCT/IB/308): _____.
   c. [ ] is not required, as the application was searched by the United States International Searching Authority.
   d. [ ] will be transmitted promptly upon request.
   e. [ ] has been submitted by applicant on _____.
      Date

12. [X] An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98:
   a. [X] is transmitted herewith.
      Also transmitted herewith is/are:
      [X] Form PTO-1449 (PTO/SB/08A and 08B).
      [X] Copies of citations listed.
   b. [ ] will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. 371(c).
   c. [ ] was previously submitted by applicant on _____.
      Date

13. [ ] An assignment document is transmitted herewith for recording.

A separate [ ] "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or[ ] FORM PTO 1595 is also attached.

_____
_____
_____

14. [X] Additional documents:
   a. [X] Copy of request (PCT/RO/101)
   b. [X] International Publication No. WO 00/08601
      i. [X] Specification, claims and drawing
      ii. [ ] Front page only
   c. [X] Preliminary amendment (37 C.F.R. § 1.121)
   d. [X] Other

Form PCT/IB/306; Form PCT/IB/306; Form PCT/IB/304

15. [X] The above checked items are being transmitted
   a. [X] before 30 months from any claimed priority date.
   b. [ ] after 30 months.

16. [ ] Certain requirements under 35 U.S.C. 371 were previously submitted by the applicant on _____, namely:

_____
_____
_____

AUTHORIZATION TO CHARGE ADDITIONAL FEES

WARNING: *Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges if extra claims are authorized.*

NOTE: "A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

NOTE: "Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

[X] The Commissioner is hereby authorized to charge the following additional fees that may be required by this paper and during the entire pendency of this application to Account No. ___.

[**X**] 37 C.F.R. 1.492(a)(1), (2), (3), and (4) (filing fees)

WARNING: *Because failure to pay the national fee within 30 months without extension (37 C.F.R. § 1.495(b)(2)) results in abandonment of the application, it would be best to always check the above box.*

[**X**] 37 C.F.R. 1.492(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.492(d)), it might be best not to authorize the PTO to charge additional claim fees, except possible when dealing with amendments after final action.

[**X**] 37 C.F.R. 1.17 (application processing fees)
[**X**] 37 C.F.R. 1.17(a)(1)-(5)(extension fees pursuant to § 1.136(a).
[ ] 37 C.F.R. 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 C.F.R. § 1.311(b).

NOTE: 37 C.F.R. 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in

the application . . . prior to paying, or at the time of paying . . . issue fee." From the wording of 37 C.F.R. § 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

[ ] 37 C.F.R. § 1.492(e) and (f) (surcharge fees for filing the declaration and/or filing an English translation of an International Application later than 30 months after the priority date).

SIGNATURE OF PRACTITIONER

Reg. No.: 33,860

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162238

Docket No. 49273

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Jürgen Pandel; Gero Bäse; and Norbert Örtel

Express Mail Label No.: EL196831827US

For: METHOD AND ARRANGEMENT FOR MOTION ESTIMATION IN A DIGITIZED PICTURE HAVING PIXELS

Assistant Commissioner For Patents
Washington, D.C. 20231
Sir:

PRELIMINARY AMENDMENT

Applicants file herewith the above application. Please amend the application as follows.

IN THE CLAIMS

Please cancel claims 1-10 without prejudice.

Please add the following new claims.

11. A method for motion estimation in a digitized image having pixels, comprising:

grouping pixels in picture blocks,

in which the pixels are grouped to form at least one first picture area and one second picture area;

wherein first motion estimation is carried out in a first search area for at least one picture block in the first picture area to determine a first motion vector whereby movement of the first picture block is described in comparison to the first picture block in a preceding predecessor picture and/or in comparison to the first picture block in a subsequent successor picture;

wherein second motion estimation is carried out in a second search area for at least one second picture block in the second search area to determine a second motion vector whereby movement of the second picture block is described in comparison to the second picture block in a preceding predecessor picture and/or in comparison to the second picture block in a subsequent successor picture;

wherein the first search area and the second search area are of different sizes; and

wherein the size of the first search area and/or of the second search area is varied as a function of a predetermined picture quality, whereby the first picture block and/or the second picture block are/is coded.

12. The method of claim 11 wherein the size of the first search area and/or of the second search area are/is varied as a function of a quantization parameter whereby the first picture block and/or the second picture block are/is quantized.

13. The method of claim 11 used for coding the digitized picture.

14. The method of claim 13 wherein variable length coding of the motion vectors is carried out; and a number of stored, different tables, in which codes for variable length coding are stored, are used for variable length coding.

15. The method of claim 14 wherein the tables are matched to the maximum length of the motion vectors.

16. An arrangement for motion estimation in a digitized image having pixels, comprising:

a processor which is set up such that the following steps can be carried out:

the pixels are grouped in picture blocks;

the pixels are grouped to form at least one first picture area and one second picture area;

first motion estimation is carried out in a first search area for at least one picture block in the first picture area to determine a first motion vector whereby movement of the first picture block is described in comparison to the first picture block in a preceding predecessor picture and/or in comparison to the first picture block in a subsequent successor picture;

second motion estimation is carried out in a second search area for at least one second picture block in the second search area to determine a second motion vector whereby movement of the second picture block is described in comparison to the second picture block in a preceding predecessor picture and/or in comparison to the second picture block in a subsequent successor picture;

in which the first search area and the second search area are of different sizes; and

in which the size of the first search area and/or of the second search area is varied as a function of a predetermined picture quality, whereby the first picture block and/or the second picture block are/is coded.

17. The arrangement of claim 16 wherein the processor is set up such that the size of the first search area and/or of the second search area are/is varied as a function of a quantization parameter whereby the first picture block and/or the second picture block are/is quantized.

18. The arrangement of claim 16 used in a picture coding device.

19. The arrangement of claim 16, used in a picture coding device,

wherein the processor is set up such that, variable length coding of the motion vectors is carried out; and a number of stored, different tables, in which codes for variable length coding are stored, are used for variable length coding.

20. The arrangement of claim 19 wherein the processor is set up such that the tables are matched to the maximum length of the motion vectors.

REMARKS

Claims 1-10 have been cancelled without prejudice, and claims 11-20 have been added. The new claims merely conform to matters of form of U.S. practice.

Early consideration and allowance of the application are earnestly solicited.

Respectfully submitted,

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Description

Method and arrangement for motion estimation in a digitized picture having pixels

The invention relates to motion estimation in a digitized picture having pixels.

Such a method is known from [1].

In the method for motion estimation from [1], pixels of a digitized block for which the motion estimation is intended to be carried out are grouped into picture blocks.

For each picture block in the picture, an attempt is made within a search area whose size can be preset to determine an area of the size of the picture block in which the similarity of the coding information which is contained in the picture block for which the motion estimation is being carried out matches as well as possible.

In the following text, the term coding information means brightness information (luminance values) or color information (chrominance values) which are each associated with a pixel.

For this purpose, in a preceding picture and based on the position in which the picture block is located in the preceding picture, a region of the corresponding block size with the same number of pixels as those contained in the picture block is in each case formed for each position in an area whose size (search area) can be predetermined, and the sum of the square or absolute difference of the coding information is formed between the picture block for which the motion estimation is intended to be carried out and the

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respective region in the preceding picture. The region which matches best, that is to say has the minimum sum value, is regarded as the matching picture block and the movement in the position of the picture block between the "best" region in the preceding picture and that picture block is determined. This movement is referred to as the motion vector.

The document Oh et al "Block-matching algorithm based on dynamic adjustment of search window for low bit-rate video coding", Journal of Electronic Imaging, US, Volume 7, No. 3, July 1998, pages 571-577 describes a method for motion estimation of objects in a video sequence using a block matching algorithm, and the use of the motion vectors determined by means of this method for compression of the video data. For estimation of the motion vectors, the individual video pictures are broken down into blocks of NxN pixels. For each picture block in the current video picture, the associated, best-matching picture block in a preceding reference video picture is determined, and the sought motion vector for this picture block is determined from the difference in the position of the block in the two video pictures. The method in this case uses a search area of variable size, in which matching picture blocks are looked for within the reference video picture.

The document US-A-5 537 155 describes a method for video compression, in which motion estimation is carried out between the individual pictures in a video sequence. Motion estimation is carried out using a block matching algorithm in which the picture blocks in the present video picture are compared with picture blocks from a preceding video picture. This comparison

is carried out with a respectively different step width in different search areas. The search is carried out with a small step width around the position of the present picture block in a first search area within the comparison picture. Searches are then carried out with correspondingly larger step widths in larger areas around the present picture block.

When the corresponding video block in the comparison picture is found, this thus defines the motion vector for this block, which is then used for coding that video block.

The invention is based on the problem of providing a method and an apparatus for motion estimation in which the total number of bits required overall for coding the motion vectors is reduced.

The problem is solved by the method and by the arrangement according to the features of the independent patent claims.

In the case of the method for motion estimation of a digitized picture having pixels, the pixels are grouped into picture blocks. The pixels are grouped at least into a first picture area and a second picture area. First motion estimation is carried out in a first search area for at least a first picture block in the first picture area in order to determine a first motion vector by means of which a movement of the first picture block is described in comparison to the first picture block in a preceding predecessor picture, and/or in comparison to the first picture block in a

subsequent successor picture. Furthermore, second motion estimation is carried out in a second search area for at least one second picture block in the second picture area in order to determine a second motion vector by means of which a movement of the second picture block is described in comparison to the second picture block in a preceding predecessor picture and/or in comparison to the second picture block in a subsequent successor picture. The first search area and

the second search area are in this case of different sizes.

The arrangement for motion estimation of a digitized picture having pixels has a processor which is set up such that the following steps can be carried out:

- the pixels are grouped into picture blocks,
- the pixels are grouped to form at least one first picture area and one second picture area,
- first motion estimation is carried out in a first search area for at least one first picture block in the first picture area in order to determine a first motion vector by means of which a movement of the first picture block is described in comparison to the first picture block in a preceding predecessor picture and/or in comparison to the first picture block in a subsequent successor picture,
- second motion estimation is carried out in a second search area for at least one second picture block in the second picture area in order to determine a second motion vector by means of which a movement of the second picture block is described in comparison to the second picture block in a preceding predecessor picture and/or in comparison to the second picture block in a subsequent successor picture, and
- the first search area and the second search area are of different sizes.

The invention makes it possible to reduce the required data rate for transmission of compressed video data, since the size of the motion vectors can be adaptively matched to qualitative requirements and thus, without noticeably detracting from the subjective impression of the quality of a picture, only a very small search area is provided even, for example, in regions in which only low quality is required. The maximum size of a motion vector in this search area is thus relatively small,

which results in the number of bits for coding the motion vector being reduced.

The invention can evidently be seen in the fact that search areas of different size are used for picture areas for motion estimation of the picture blocks in the picture areas, which results in flexible reduction, matched to the quality, of the required data rate for coding for motion vectors.

Advantageous developments of the invention result from the dependent claims.

One development provides for the size of the first search area and/or of the second search area to be varied as a function of a predetermined picture quality, by means of which the first picture block and/or the second picture block are/is coded.

In this way, a measure for limiting the search areas is specified, which allows a reduction in the required data rate taking account of the required picture quality.

One extremely simple criterion for determining the size of the respective search area, in one development, is a quantization parameter by means of which the first picture block and/or the second picture block are/is quantized.

A further refinement provides for a number of tables, in which codes for variable length coding are stored, to be used for variable length coding of the motion vectors, and this results in a further reduction in the required data rate for transmission of the video data.

An exemplary embodiment of the invention will be explained in more detail in the following text and is illustrated in the figures, in which:

Figures 1a to 1c show a sketch of a picture and of a preceding picture, in which the principle on which the invention is based is illustrated;

Figure 2 shows an arrangement of two computers, a camera and a screen, by means of which the video data are coded, transmitted, decoded and displayed;

Figure 3 shows a sketch of an apparatus for block-based coding of a digitized picture.

Figure 2 shows an arrangement which comprises two computers 202, 208 and a camera 201, showing picture coding, transmission of the video data, and picture decoding.

A camera 201 is connected to a first computer 202 via a line 219. The camera 201 transmits pictures 204 it has filmed to the first computer 202. The first computer 202 has a first processor 203 which is connected via a bus 218 to a frame memory 205. A method for picture coding is carried out by the first processor 203 in the first computer 202. In this way, coded video data 206 are transmitted from the first computer 202 via a communications link 207, preferably a cable or a radio path, to a second computer 208. The second computer 208 contains a second processor 209, which is connected to a frame memory 211 via a bus 210. A method for picture decoding is carried out by means of the second processor 209.

Both the first computer 202 and the second computer 208 have a respective screen 212 or 213, on which the video data 204 are displayed. Input units, preferably a keyboard 214 or 215 and a computer mouse 216 or 217,

are respectively provided for both the first computer 202 and the second computer 208.

The video data 204 which are transmitted from the camera 201 via the line 219 to the first computer 202 are data in the time domain, while the data 206 which are transmitted from the first computer 202 to the second computer 208 via the communications link 207 are video data in the spectral domain.

The decoded video data are displayed on a screen 213.

Figure 3 shows a sketch of an arrangement for carrying out a block-based picture coding method in accordance with the H.263 Standard (see [5]).

A video data stream to be coded and having successive digitized pictures is supplied to a picture coding unit 301. The digitized pictures are subdivided into macro blocks 302, with each macro block containing 16x16 pixels. The macro block 302 comprises four picture blocks 303, 304, 305 and 306, with each picture block containing 8x8 pixels, to which luminance values (brightness values) are assigned. Furthermore, each macro block 302 comprises two chrominance blocks 307 and 308 having the chrominance values assigned to the pixels (color information, color saturation).

The block in a picture contains a luminance value (= brightness), a first chrominance value and a second chrominance value. In this case, the luminance value, the first chrominance value and the second chrominance value are referred to as color values.

The picture blocks are supplied to a transformation coding unit 309. During difference-picture coding, the values to be coded from picture blocks from preceding pictures are subtracted from the picture blocks to be

coded at that time, and only the difference-forming information 310 is supplied to the transformation coding unit (Discrete Cosine Transformation, DCT) 309. For this purpose, the present macro block 302 is signaled to a motion estimation unit 329 via a link 334. In the transformation coding unit 309, spectral coefficients 311 are formed for the picture blocks or difference picture blocks to be coded, and are supplied to a quantization unit 312.

Quantized spectral coefficients 313 are supplied both to a scanning unit 314 and to an inverse quantization 315 in a feedback path. Using a scanning method, for example a "zigzag" scanning method, entropy coding is carried out on the scanned spectral coefficients 332 in an entropy coding unit 316 provided for this purpose. The entropy-coded spectral coefficients are transmitted as coded video data 317 via a channel, preferably a cable or a radio path, to a decoder.

Inverse quantization of the quantized spectral coefficients 313 is carried out in the inverse quantization unit 315. Spectral coefficients 318 obtained in this way are supplied to an inverse transformation coding unit 319 (Inverse Discrete Cosine Transformation, IDCT). Reconstructed coding values (and difference coding values) 320 are supplied to an adder 321 in the difference-forming mode. The adder 321 also receives coding values for a picture block, which are obtained from a preceding picture once motion compensation has already been carried out. The adder 321 is used to form reconstructed picture blocks 322, which are stored in a frame memory 323.

Chrominance values 324 of the reconstructed picture blocks 322 are supplied from the frame memory 323 to a motion compensation unit 325. For brightness values 326, interpolation is carried out in an interpolation

unit 327 provided for this purpose. The interpolation is preferably used to quadruple the number of brightness values contained in the respective picture block. All the brightness values 328 are supplied not only to the motion compensation unit 325 but also to the motion estimation unit 329. The motion estimation unit 329 also receives the picture blocks for the respective macro block (16x16 pixels) to be coded, via the link 334. Motion estimation is carried out in the motion estimation unit 329, taking account of the interpolated brightness values ("motion estimation on a half-pixel basis").

The result of the motion estimation is a motion vector 330 which expresses a movement in the position of the selected macro block from the preceding picture to the macro block 302 to be coded.

Both brightness information and chrominance information relating to the macro block determined by the motion estimation unit 329 are shifted through the motion vector 330, and are subtracted from the coding values of the macro block 302 (see data path 231).

The motion estimation thus results in the motion vector 330 with two motion vector components, a first motion vector component BV_x and a second motion vector component BV_y along the first direction x and the second direction y:

$$BV = \begin{pmatrix} BV_x \\ BV_y \end{pmatrix}$$

The motion vector 330 is assigned to the picture block.

The picture coding unit shown in Figure 3 thus provides a motion vector 330 for all the picture blocks and macro picture blocks.

Figure 1a shows a digitized picture 100 which is intended to be coded using the apparatus illustrated in Figure 3.

The digitized picture 100 has pixels 101 to which coding information is assigned.

The pixels 101 are grouped into picture blocks 102. The picture blocks 102 are grouped into a first picture area 105 and into a second picture area 106.

In the following text, it is assumed that the quality requirements in the first picture area 105 are more stringent than the requirements for the quality in the second picture area 106.

Motion estimation is carried out for a first picture block 103 in the first picture area 105. To this end, a first search area 114 is defined in a preceding picture and/or in a subsequent picture 110.

Based on a starting region 113 whose shape and size are the same as those of the first picture block, the following error E is in each case determined, shifted by one pixel or by a fraction or a multiple of the pixel separation (for example by half a pixel (half-pixel motion estimation)) through which the start region 113 is in each case shifted:

$$E = \sum_{i=1}^{n} \sum_{j=1}^{m} \left(x_{i,j} - y_{i,j}\right)^2 ,$$

Where

- i,j are sequential indices,

- n is the number of pixels in the first picture block along a first direction,
- m is the number of pixels in the first picture block along a second direction,
- $x_{i,j}$ is coding information for the pixel at the position i,j within the first picture block,
- $y_{i,j}$ is coding information for the pixel at the corresponding point in the previous picture, shifted through the corresponding motion vector.

The error E is calculated for each shift in the previous picture 110 and the picture block from that shift (= motion vector) whose error E has the lowest value is selected as that which is most similar to the first picture block 103.

In this exemplary embodiment, the search area in each case covers four pixel intervals, both in the horizontal direction and in the vertical direction, about a start position 113 which corresponds to the relative position of the first picture block of the first picture area in the preceding picture 110. The maximum size of a first motion vector 117 to be coded is thus $4\sqrt{2}$ pixel intervals in this case (see **Figure 1b**).

Figure 1c shows second motion estimation for a second picture block 104 in the second picture area 106. The fundamental procedure for the purposes of motion estimation is also described as above for the second motion estimation.

For the second motion estimation, a second search area 116 is smaller, since the requirements for the picture quality in the second picture area 106 are not as stringent as those for the first picture area 105.

For this reason, the size of the second search area 116 is only two pixels 116 in each direction, originating from a start position 115. The maximum size of a second motion vector 118 to be coded for the second picture block 104 is thus $2\sqrt{2}$.

It can be seen from this example that considerably less computation effort is required for coding the second motion vector 118 than for coding the first motion vector 117.

Based on this illustrative example, the size of a search area for a picture block in the exemplary embodiment is dependent on a quantization parameter which indicates the quantization steps which were used to code the preceding picture 100.

The size S of a search area is obtained using the following rule:

$$S = 15 - QP/2$$

where

- S is the size of the search area, and
- QP is the quantization parameter.

The quantization parameter QP is a factor contained in the normal header data for H.263, and is used as the start value for the quantization.

The size S of the search area for a picture block thus becomes larger the smaller the quantization parameter QP, which corresponds to high picture quality.

A number of tables, which contain different codes for motion vectors of different length with a different

value range, are used for variable length coding of the motion vectors.

The quantization parameter QP is used to select that table for variable length coding whose table entries for the variable length codes have a value range which is matched to the size S of the search area, and thus to the maximum length of the motion vector.

A number of alternatives to the exemplary embodiment described above are explained below.

The type of motion estimation, and thus the way in which the similarity measure is formed, are irrelevant to the invention.

Thus, for example, the following rule can also be used to form the error E:

$$E = \sum_{i=1}^{n} \sum_{j=1}^{m} |x_{i,j} - y_{i,j}| .$$

It has furthermore been shown that, for further reduction of the required data rate, it is in many cases even sufficient to transmit only the motion vectors without also transmitting an error signal which is produced during the formation of the difference pictures for motion compensation.

The invention can evidently be seen in the fact that search areas of different size are used for picture areas for motion estimation of the picture blocks in the picture areas, which results in a flexible reduction, matched to the quality, in the required data rate for coding of the motion vectors.

The following publication is cited in this document:

[1] ITU-T Draft Recommendation H.263, Video Coding for Low Bitrate Communication, May, 1996.

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Patent Claims

1. A method for motion estimation in a digitized image having pixels,
   - in which the pixels are grouped in picture blocks,
   - in which the pixels are grouped to form at least one first picture area and one second picture area,
   - in which first motion estimation is carried out in a first search area for at least one first picture block in the first picture area in order to determine a first motion vector by means of which a movement of the first picture block is described in comparison to the first picture block in a preceding predecessor picture and/or in comparison to the first picture block in a subsequent successor picture,
   - in which second motion estimation is carried out in a second search area for at least one second picture block in the second search area in order to determine a second motion vector by means of which a movement of the second picture block is described in comparison to the second picture block in a preceding predecessor picture and/or in comparison to the second picture block in a subsequent successor picture,
   - in which the first search area and the second search area are of different sizes, and
   - in which the size of the first search area and/or of the second search area is varied as a function of a predetermined picture quality, by means of which the first picture block and/or the second picture block are/is coded.

2. The method as claimed in claim 1,

characterized in that the size of the first search area and/or of the second search area are/is varied as a function of a quantization parameter by means of which the first picture block and/or the second picture block are/is quantized.

3. The method as claimed in one of claims 1 to 2, used for coding the digitized picture.

4. The method as claimed in claim 3,
- in which variable length coding of the motion vectors is carried out,
- in which a number of stored, different tables, in which codes for variable length coding are stored, are used for variable length coding.

5. The method as claimed in claim 4,
characterized in that the tables are matched to the maximum length of the motion vectors.

6. An arrangement for motion estimation in a digitized picture having pixels,
having a processor which is set up such that the following steps can be carried out:
- the pixels are grouped into picture blocks,
- the pixels are grouped to form at least one first picture area and one second picture area,
- first motion estimation is carried out in a first search area for at least one first picture block in the first picture area in order to determine a first motion vector by means of which a movement of the first picture block is described in comparison to the first picture block in a preceding predecessor picture and/or in comparison to the first picture block in a subsequent successor picture,

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- second motion estimation is carried out in a second search area for at least one second picture block in the second picture area in order to determine a second motion vector by means of which a movement of the second picture block is described in comparison to the second picture block in a preceding predecessor picture and/or in comparison to the second picture block in a subsequent successor picture,
- the first search area and the second search area are of different sizes, and
- wherein the processor is set up such that the size of the first search area and/or of the second search area are/is varied as a function of a predetermined picture quality by means of which the first picture block and/or the second picture block are/is coded.

7. The arrangement as claimed in claim 6, wherein the processor is set up such that the size of the first search area and/or of the second search area are/is varied as a function of a quantization parameter by means of which the first picture block and/or the second picture block are/is quantized.

8. The arrangement as claimed in one of claims 6 or 7, used in a picture coding device.

9. The arrangement as claimed in one of claims 6 or 7, used in a picture coding device, wherein the processor is set up such that
- variable length coding of the motion vectors is carried out,

- a number of stored, different tables, in which codes for variable length coding are stored, are used for variable length coding.

10. The arrangement as claimed in claim 9, characterized in that the processor is set up such that the tables are matched to the maximum length of the motion vectors.

GR 98 P 2279

Abstract

Method and arrangement for motion estimation in a digitized picture having pixels

The pixels are grouped into picture blocks. The pixels are grouped into at least a first picture area and a second picture area. First motion estimation is carried out in a first search area in order to determine a first motion vector. Furthermore, second motion estimation is carried out in a second search area in order to determine a second motion vector. The first search area and the second search area are of different sizes.

Significant Figures 1a - 1c

FIG 1A

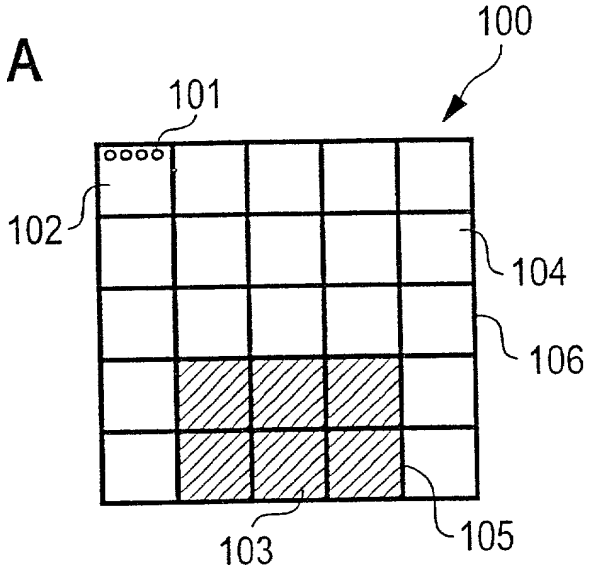

FIG 1B

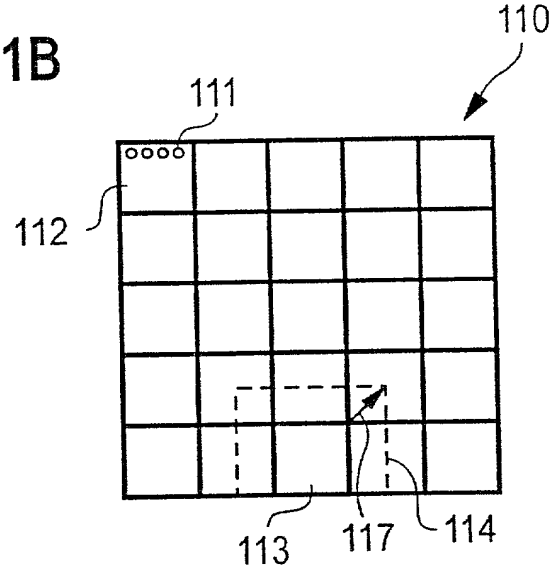

FIG 1C

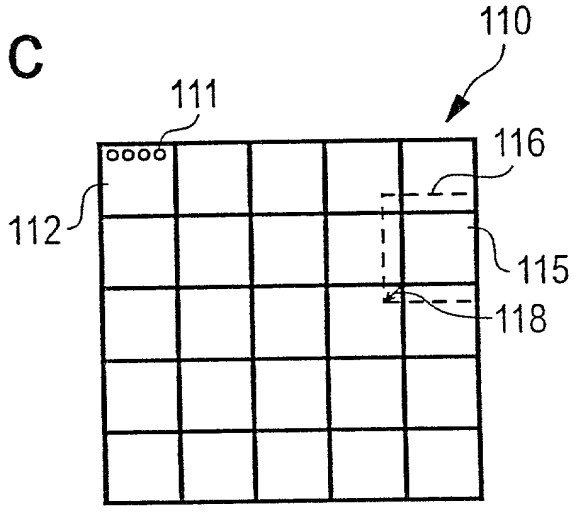

FIG 2

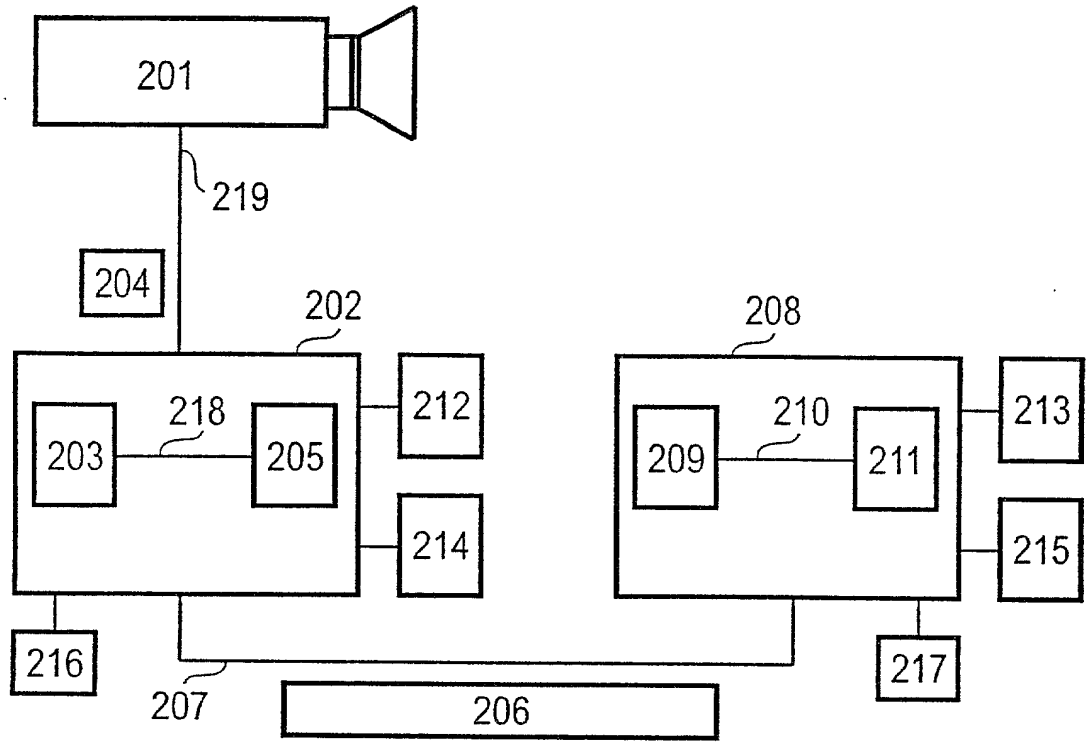
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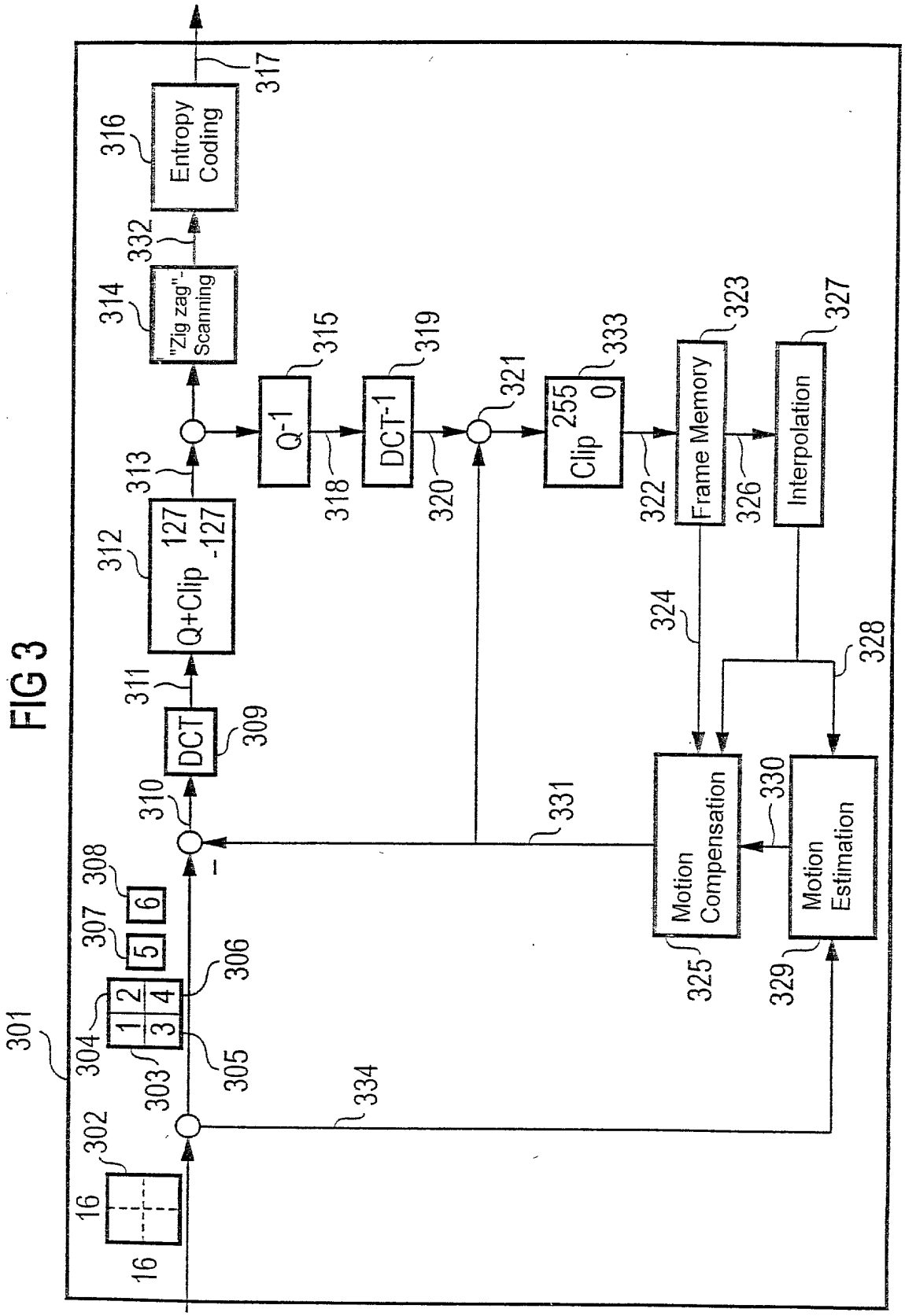
FIG 3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Q+Clip
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-127
313
314
"Zig zag"-
Scanning
332
316
Entropy
Coding
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315
Q-1
318
319
DCT-1
320
321
Clip
255
0
333
322
323
Frame Memory
326
327
Interpolation
324
328
325
Motion
Compensation
330
329
Motion
Estimation
331
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DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that: My residence, post office address and citizenship are as stated below next to my name. I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled: METHOD AND ARRANGEMENT FOR MOTION ESTIMATION IN DIGITIZED PICTURE HAVING PIXELS

which is described and claimed in:

☐ the specification attached hereto.

☑ the specification in U.S. Application Serial Number _____, filed on 7 February 2001.

☑ the specification in PCT international application Number, **PCT/DE99/02406** filed on **August 2, 1999**; and was amended on _____.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a). I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

Prior Foreign/PCT Applications and Any Priority Claims Under 35 U.S.C. §119:			
Application No.	**Filing Date**	**Country**	**Priority Claimed Under 35 U.S.C. §119?**
DE 198 35 845.8	**August 7, 1998**	**Germany**	☑YES ☐NO
			☐YES ☐NO
			☐YES ☐NO

I hereby claim the benefit under 35 U.S.C. §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below, and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose material information as defined in 37 CFR §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

Prior U.S. Applications or PCT International Applications Designating the U.S-Benefit Under 35 U.S.C. §120				
U.S. Applications		Status (Check One)		
Application Serial No.	U.S. Filing Date	Patented	Pending	Abandoned
PCT Applications Designating the U.S.				
Application No.	Filing Date	U.S. Serial No. Assigned			
PCT/DE99/02406	August 2, 1999			X	

CLAIM FOR BENEFIT OF PRIOR U.S. PROVISIONAL APPLICATION(S)
(35 U.S.C. §119(e))

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below:

Applicant	Provisional Application Number	Filing Date

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) with full powers of association, substitution and revocation to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

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206	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE OR COUNTRY AND ZIP CODE

I hereby further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Signature of Inventor **201**	Signature of Inventor **202**
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Signature of Inventor **205**	Signature of Inventor **206**
Date:	Date: